VERIFICATION OF TRANSLATION

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I, Motohiko Nagashima of 2-1-417, Hakusan 2-chome, Asao-ku, Kawasaki-shi, Kanagawa 215-0014 Japan, am the translator of the documents attached and I state that the following is a true translation to the best of my knowledge and belief of Japanese Patent Application No. 2001-023474.

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Signature of translator Motohiko Nagashima
Motohiko Nagashima

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[Inventor]

[Address] c/o Shiga Plant, Toray Industries, Inc., 1-1, Sonoyama 1-chome, Otsu-shi, Shiga

[Name] Yoshiyuki KITAMURA

[Inventor]

[Address] c/o Shiga Plant, Toray Industries, Inc., 1-1, Sonoyama 1-chome, Otsu-shi, Shiga

[Name] Hiromitsu KANAMORI

[Inventor]

[Address] c/o Shiga Plant, Toray Industries, Inc., 1-1, Sonoyama 1-chome, Otsu-shi, Shiga

[Name] Shigeo FUJIMORI

[Applicant for Patent]

[Id. No.] 000003159

[Address] 2-1, Nihonbashi-Muromachi 2-chome, Chuo-ku, Tokyo

[Name] Toray Industries, Inc.

[Representative] Katsuhiko HIRAI

[Phone No.] 03-3245-5648

[Application Fees]

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[List of Documents Attached]

[Name of Document]	Specification	1
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[Name of Document]	Abstract	1

[Proof] Required

[Name of Document] SPECIFICATION

[Title of the Invention] INTEGRATED MASK AND METHOD AND APPARATUS FOR MANUFACTURING ORGANIC EL DEVICE USING THE INTEGRATED MASK

[Claims]

[Claim 1] An integrated mask comprising a plurality of deposition masks, each deposition mask having an array of deposition apertures formed in accordance with a deposition pattern and a base plate having a plurality of openings, wherein the deposition masks are arranged on the base plate such that the arrays of deposition apertures are positioned above the respective openings and are retained to the base plate by engaging means in a disengageable manner, and wherein alignment marks used for positioning the deposition masks on the base plate are formed on the base plate.

[Claim 2] An integrated mask according to Claim 1, wherein the engaging means disengages the deposition masks when an external force is applied.

[Claim 3] An organic EL device manufacturing method comprising the steps of positioning the integrated mask according to Claim 1 and a substrate to be subjected to a deposition process in a deposition chamber using the alignment marks of the integrated mask and patterning a thin film layer in the deposition process using the integrated mask, thereby forming a plurality of organic EL devices.

[Claim 4] An organic EL device manufacturing method

comprising the steps of positioning the integrated mask according to Claim 1 and a substrate to be subjected to a deposition process using the alignment marks of the integrated mask; putting the integrated mask and the substrate in a deposition chamber; and patterning a thin film layer in the deposition process using the integrated mask, thereby forming a plurality of organic EL devices.

[Claim 5] An organic EL device manufacturing method according to Claim 3 or 4, wherein the thin film layer is one of R, G, and B emitting layers.

[Claim 6] An organic EL device manufacturing apparatus comprising a positioning apparatus used for positioning the integrated mask according to Claim 1 and a substrate to be subjected to a deposition process based on the alignment marks of the integrated mask and a deposition apparatus used for patterning a thin film layer in the deposition process using the deposition mask.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a deposition mask for manufacturing organic EL devices which are able to convert electrical energy into light, and which have various applications in devices such as display devices, flat panel displays, backlights, illuminations, interior decorations, signboards, electronic cameras, etc. In addition, the

present invention also relates to a method and apparatus for manufacturing an organic EL device using the deposition mask.

[0002]

[Description of the Related Art]

In organic EL devices, light is emitted when electrons supplied from cathodes and holes supplied from anodes are recombined inside an organic fluorescent substance disposed between the cathodes and the anodes. Organic EL devices have become commonly used in thin, compact displays because of their simple structure and ability to emit high-intensity, multicolored light at low voltage.

[0003]

In order to manufacture a full-color display panel using an organic EL device, thin film layers including red (R), green (G), and blue (B) emitting layers, a first electrode layer, a second electrode layer, etc., must be regularly formed in a predetermined pattern with a predetermined pitch.

[0004]

In the above-described thin film layers, in order to form organic thin film layers which function as the emitting layers in a precise pattern, a mask deposition method is normally applied from the viewpoint of the characteristics of the organic thin film layers. In the mask deposition method, a deposition process is performed in a vacuum using a mask having apertures formed in accordance with a predetermined pattern of the emitting layer.

[0005]

[Problems to be Solved by the Invention]

In order to increase the productivity in manufacturing the organic EL devices, it is advantageous to simultaneously form multiple organic EL devices on a single, large substrate. This is because a mask deposition used for forming emitting layers is performed in a batch-wise manner, substrate by substrate, and the existing organic devices are mainly used in compact apparatuses. In the case in which multiple organic EL devices are simultaneously formed on a single, large substrate, a deposition mask having a plurality of arrays of apertures, each array corresponding to a single organic EL device, must be prepared. However, in such a case, the size of such a deposition mask is increased, and the deposition mask is greatly deformed in the manufacturing process and the deposition process. Thus, the high dimensional accuracy of the arrays of apertures cannot be maintained sufficiently. Accordingly, JP 2000-113978 A discloses means for maintaining the high dimensional accuracy by using an integrated deposition mask in which a plurality of deposition masks, each of which has an array of apertures corresponding to a single organic EL device, are arranged. However, the detailed structure of the integrated deposition mask is not described.

[0006]

Since three emitting layers corresponding to RGB three

colors are formed, it is important to accurately adjust the relative positions between each of the emitting layers. Although a method for positioning a single deposition mask relative to a substrate has been disclosed in JP 11-158605 A, means for positioning the above-described integrated deposition mask, with which multiple organic EL devices can be formed simultaneously with high accuracy, relative to a substrate has not been suggested.

[0007]

In view of the above-described situation, an object of the present invention is to provide a construction for practically using an integrated deposition mask in which a plurality of deposition masks, each of which has an array of apertures corresponding to a single organic EL device, are arranged. In addition, another object of the present invention is to provide a method and apparatus for manufacturing an organic EL device by which the integrated deposition mask and a substrate can be accurately positioned, multiple organic EL devices can be formed on a single substrate by a deposition process, and the productivity in manufacturing organic EL devices can be significantly increased.

[0008]

[Means for Solving the Problems]

The above-described objects are achieved by the present invention.

The present invention provides an integrated mask including a plurality of deposition masks, each deposition mask having an array of deposition apertures formed in accordance with a deposition pattern and a base plate having a plurality of openings. The deposition masks are arranged on the base plate such that the arrays of deposition apertures are positioned above the respective openings and are retained to the base plate by engaging means in a disengageable manner, and alignment marks used for positioning the deposition masks on the base plate are formed on the base plate. In addition, the present invention also provides a method and apparatus for manufacturing an organic EL device using the integrated mask.

[0009]

[Description of the Embodiments]

An integrated mask according to the present invention includes a plurality of deposition masks, each deposition mask having an array of deposition apertures formed in accordance with a deposition pattern and a base plate having a plurality of openings. The deposition masks are arranged on the base plate such that the arrays of deposition apertures are positioned above the respective openings and are retained to the base plate by engaging means in a disengageable manner, and alignment marks used for positioning the deposition masks on the base plate are formed on the base plate. The fact that the arrays of deposition

apertures are positioned above the respective openings means that the areas of the openings are larger than the areas of their respective arrays of deposition apertures, that is, the deposition patterns. In addition, although the engaging means which retains the deposition masks in a disengageable manner is not particularly limited, it preferably disengages the deposition masks when an external force is applied.

[0010]

An organic EL device manufacturing method according to the present invention includes the steps of positioning the integrated mask of the present invention and a substrate to be subjected to a deposition process in a deposition chamber based on the alignment marks of the integrated mask and patterning a thin film layer in the deposition process using the integrated mask, thereby forming a plurality of organic EL devices. Alternatively, the step of positioning the integrated mask and the substrate may be performed before putting the integrated mask and the substrate in the deposition chamber, and then the step of patterning a thin film layer in the deposition process using the integrated mask may be performed. Thus, the positioning step may be performed at any suitable place in accordance with the arrangement or construction of the apparatus, and it is important that the positioning step be performed in the present invention. Preferably, the thin film layer formed in the deposition process using the integrated mask of the

present invention is one of R, G, and B emitting layers.

[0011]

An organic EL device manufacturing apparatus according to the present invention includes a positioning apparatus used for positioning the integrated mask of the present invention and a substrate to be subjected to a deposition process based on the alignment marks of the integrated mask and a deposition apparatus used for patterning a thin film layer in the deposition process using the deposition mask. The deposition apparatus includes a deposition chamber and an evaporation source disposed inside the deposition chamber, and a deposition layer having a pattern corresponding to a pattern of a deposition mask is formed on a substrate in this deposition apparatus. The positioning apparatus used for positioning the integrated mask and the substrate may be disposed inside or outside the deposition chamber. In the case in which the positioning apparatus is disposed outside the deposition chamber, the organic EL device manufacturing apparatus may include a device for transferring the integrated mask and the substrate into the deposition chamber after the positioning.

[0012]

In the integrated mask of the present invention, it becomes possible to arrange multiple deposition masks at predetermined positions with high accuracy, since the deposition masks having predetermined array of deposition

apertures are positioned on the base plate based on both fiducial marks, and are retained by the engaging means in a disengageable manner.

[0013]

In the method and apparatus for manufacturing the organic EL device of the present invention, the step of positioning the integrated mask and the substrate and the step of forming a thin film layer, for example, an emitting layer, are performed using the above-described integrated mask. Accordingly, the thin film layer can be formed in a predetermined pattern by deposition at high dimensional accuracy, irrespective of the size of the substrate on which the thin film layer is formed. In addition, since multiple organic EL devices can be formed on a single substrate at high pattern accuracy, high quality organic EL devices can be manufactured with high productivity.

[0014]

Preferred embodiments of the present invention will be described below with reference to the accompanying drawings.

[0015]

Fig. 1 is a schematic perspective view showing an overall construction of an integrated mask 1 according to the present invention, and Fig. 2 is an exploded perspective view of the integrated mask 1 shown in Fig. 1. In addition, Fig. 3 is a front sectional view showing an embodiment of a deposition apparatus using the integrated mask, and Fig. 4 is

a front sectional view showing another embodiment of a deposition apparatus using the integrated mask.

[0016]

With reference to Fig. 1, the integrated mask 1 is constructed by retaining four deposition masks 20 on a base plate 2 with engaging units 40.

[0017]

Each of the deposition masks 20 is set up by retaining a mask plate 22 provided with an aperture array 30 on a frame 24, the aperture array 30 having a plurality of deposition apertures 32 arranged in accordance with a deposition pattern. The frame 24 has an opening, the shape of which is shown by the dashed line, so that the space directly below the aperture array 30 of the deposition masks 20 is vacant. In addition, as shown in Fig. 2, the base plate 2 is provided with openings 10 at positions where the deposition masks 20 are placed, and the area of each of the openings 10 is larger than the area of the aperture array 30 so that the aperture array 30 is placed in the corresponding opening 10. The deposition apertures 32 are formed in the shape of, for example, rectangles, circles, etc., in accordance with the deposition pattern. The area of the openings 10 is preferably larger than the area of the aperture array 30 by 5% to 500%, and more preferably, by 20% to 100%.

[0018]

Each of the deposition masks 20 is positioned on the

base plate 2 such that the deposition apertures 32 are at predetermined positions by using alignment marks 6 formed on the top surface 8 of a projecting member 4 of the base plate 2 as the reference. The positions of the deposition apertures 32 may be directly detected and the deposition masks 20 may be positioned relative to the alignment marks 6 on the base plate 2 on the basis of the detection result. However, the mask plates 22 of the deposition masks 20 are preferably provided with alignment marks 26, and the positions of the alignment marks 26 are preferably adjusted relative to the alignment marks 6 on the base plate 2. In addition, the top surface 8 of the projecting member 4 on which the alignment marks 6 are formed and the top surface of the mask plate 22 of the deposition masks 20 placed on the base plate 2 are at the same height, so that the top surface 8 of the projecting member 4 and the top surface of the mask plate 22 have the same focal position. In this case, the position detection can be easily performed using a camera.

[0019]

As shown in Fig. 1, each of the engaging units 40 includes a restraining pin 42, a compression spring 44, and a catch 46. The restraining pins 42 are inserted through holes 28 formed in the deposition masks 20 and attachment holes 18 formed in the base plate 2. The compression springs 44 are attached to the restraining pins at the lower side of the base plate 2, and the catches 46 are fixed to the restraining

pins 42 so that the restraining pins 42 cannot be pulled out. Thus, the deposition masks 20 are pressed against the base plate 2 by a predetermined force applied by the compression springs 44, and are retained such that the deposition masks 20 cannot move due to the friction. If the catches 46 are pressed upward from below, the compression springs 44 are compressed and gaps are generated between the heads of the restraining pins 42 and the deposition masks 20. Accordingly, the pressing force applied to the deposition masks 20 against the base plate 2 is removed, and the deposition masks 20 are able to move over the base plate 2. The deposition masks 20 are positioned relative to the base plate 2 while the retaining force is removed in this manner. When the positioning process is completed, the upward pressing force applied to the catches 46 is removed, so that the deposition masks 20 are retained by being pressed against the base plate 2 by the spring force of the engaging units 40.

[0020]

Next, a deposition system 100 for actually forming an emitting layer, etc., using the integrated mask 1 will be described. A deposition apparatus 102 in which the integrated mask 1 is processed is shown in Fig. 3. The integrated mask 1 is supported by a mask holder 112 disposed in a vacuum chamber 132 covered by an external wall 108, and the base plate 2 of the integrated mask 1 is fixed by fixing members 118 so that the base plate 2 cannot move on the mask

holder 112. The vacuum chamber 132 is connected to a vacuum suction unit (not shown), and the degree of vacuum is adjusted to the value required for the deposition process. A glass substrate A is supported by a substrate holder 122 in the vacuum chamber 132 at the bottom surface thereof. In addition, the substrate holder 122 is connected to a motor 128 placed outside the vacuum chamber via a bracket 120 and an elevation shaft 126. The elevation shaft 126 includes guides and a driver which can move in the vertical direction, and is able to move the substrate holder 122 in the vertical direction. In addition, the motor 128 is able to rotate the elevation shaft 126 and the components attached thereto. Accordingly, the substrate A can be freely moved in the vertical direction and rotated in a horizontal plane by the elevation shaft 126 and the motor 128 inside the vacuum chamber 132.

[0021]

The mask holder 112 is connected to an X-Y guide 116. The X-Y guide 116 is fixed at the upper side of the external wall 108. The X-Y guide 116 can be freely moved in the X and Y directions by a driver (not shown), so that the integrated mask 1 on the mask holder 112 can be freely moved in a horizontal plane. The alignment marks of the integrated mask 1 and the substrate A and the apertures formed in the deposition masks are observed by a camera 130 through a looking glass 104 formed in the external wall. In accordance

with the observation result, the integrated mask 1 and the substrate A are positioned relative to each other in the horizontal direction by the X-Y guide 116 and in the rotational direction by the motor 128. When the alignment marks of the substrate A are observed, the elevation shaft 126 is moved downward while the substrate A is placed on the integrated mask 1. Then, after the positioning process is performed while the substrate A is placed on the integrated mask 1, a pressing member 124, which can be moved in the vertical direction relative to the bracket 120 by a driver (not shown), is moved downward until it comes into contact with the substrate A, so that the adhesion force between the substrate A and the integrated mask 1 is increased. Alternatively, the adhesion force between the substrate A and the integrated mask 1 may also be increased by forming at least a part of the pressing member 124 of a magnetic material so that a magnetic attraction force is applied to the deposition masks 20, which is formed of a metal or a magnetic material.

[0022]

In addition, an evaporation source 134 is provided under the integrated mask 1 in the vacuum chamber 132. When a material is inserted in the evaporation source 134 and is heated to a predetermined temperature so that the material evaporates, only some of the material that passes through the deposition apertures included in the aperture array 30 of the

deposition masks 20 in the integrated mask 1 adheres to the substrate A. Accordingly, a layer having a predetermined pattern is formed on the substrate A. In order to freely start/shop the deposition on the substrate, a moveable deposition shutter 114 is disposed at the upper side of the evaporation source 134. In addition, when the substrate A is transferred into and out of the vacuum chamber 132, a moveable shutter 136 is opened, and the substrate A is carried through an opening 138 formed in the external wall 108 by a transfer apparatus 200.

[0023]

The transfer apparatus 200 includes a base plate 204 which can be rotated and moved vertically relative to a base 202 and a slide plate 210 which can be reciprocated above the base plate 204 by guides 206. The substrate A is placed on pads 208 disposed on the slide plate 210, and is transferred to any position within the moveable range.

[0024]

Next, the deposition method using the deposition system 100 will be described with reference to Fig. 3.

[0025]

First, the integrated mask 1 is placed on the mask holder 112 in the vacuum chamber 132, and is fixed. Then, the alignment marks 6 of the integrated mask 1 are observed by the camera 130, and the positions thereof are determined and memorized by an image processing unit (not shown).

[0026]

Then, the shutter 136 is opened and the substrate A is placed on the substrate holder 122 by the transfer apparatus 200. After the slide plate 210 of the transfer apparatus 200 has moved out from the vacuum chamber 132, the shutter 136 is closed, and the vacuum pump (not shown) is driven such that the degree of vacuum in the vacuum chamber 132 is adjusted to a predetermined value. Then, the elevation shaft 126 is moved downward and the substrate A is placed on the integrated mask 1, and the alignment marks of the substrate A are observed by the camera 130 through the looking glass 104. Then, the elevation shaft 126 is moved upward until the substrate A comes away from the integrated mask 1, and the X-Y guide 116 and the motor 128 are moved and rotated by predetermined amounts so that the positions of the alignment marks of the integrated mask 1 and the positions of the alignment marks of the substrate A are made the same.

[0027]

After the above-described positioning process, the alignment marks of the integrated mask 1 are observed by the camera 130. Then, the elevation shaft 126 is moved downward and the substrate A is placed on the integrated mask 1, and the alignment marks of the substrate A are observed by the camera 130. In this case, since the positions of the alignment marks 6 of the integrated mask 1 and the alignment marks of the substrate A can be corrected by calculation, it

is not necessary to place them at the same positions. However, the alignment marks of the integrated mask 1 and those of the substrate A are preferably at the same positions since subsequent processes of calculation, etc., can be omitted in such a case. When the alignment marks of the integrated mask 1 and those of the substrate A are not at the same positions, the elevation shaft 126 is moved upward until the substrate A comes away from the integrated mask 1, and the process of adjusting the relative position is performed similarly as described above. Then, the processes of observing and adjusting the positions of the alignment marks 6 of the integrated mask 1 and those of the substrate A are repeated until the alignment marks 6 of the integrated mask 1 and those of the substrate A are observed at the same positions. Then, the pressing member 124 is moved downward, and the pressing member 124 presses the substrate A against the integrated mask 1. The pressing force is preferably in the range of 10 to 100 N.

[0028]

Then, the evaporation source 134 is heated so that an organic material evaporates, and the deposition shutter 114 is opened so that the organic material adheres to the substrate A in accordance with the mask pattern. When an organic layer having a predetermined thickness is formed, the deposition shutter 114 is closed and the deposition process is stopped. Then, the pressure in the vacuum chamber 132 is

increased to atmospheric pressure. At the same time, the pressing member 124 is moved upward and the shutter 136 is opened, and the substrate A, on which the organic layer having the pattern corresponding to the mask pattern is formed, is carried out by the transfer apparatus 200 and is transferred to the place where the next process is performed.

[0029]

Since a relatively long time is required for adjusting the degree of vacuum in the vacuum chamber 132 to the predetermined value, the transfer apparatus 200 may be disposed inside the vacuum chamber and all of the processes may be performed under vacuum conditions. In such a case, the process of repeatedly changing the pressure inside the vacuum chamber between atmospheric pressure and vacuum can be omitted and the efficiency can be improved.

[0030]

Next, another embodiment of a deposition apparatus using the integrated mask 1 will be described below with reference to Fig. 4. Fig. 4 shows a deposition system 400. The deposition system 400 includes a positioning apparatus 300 used for positioning the substrate A on the integrated mask 1, a transfer apparatus 200 used for transferring a substrate-mask unit 420, in which the substrate A is disposed on the integrated mask in such a manner that the alignment marks of the substrate A and those of the integrated mask are at the same positions, and a deposition apparatus 402 which receives

the substrate-mask unit 420 and performs a process of depositing an organic material.

[0031]

The positioning apparatus 300 includes a mask holder 302 which supports the integrated mask 1; an X-Y table 304 which freely moves the mask holder 302 in a horizontal plane (in the X and Y directions); a substrate holder 306 which supports the substrate A; a rotation motor 314 to which the substrate holder 306 is connected via a bracket 318 and an elevation shaft 312; a frame 316 which supports the rotation motor 314; a base 308 which supports the frame 316 and the X-Y table 304; and a camera 310 which observes the alignment marks of the integrated mask 1 and the substrate A. The elevation shaft 312 includes guides and a driver which can move in the vertical direction, and is able to move the substrate holder 306 in the vertical direction. In addition, the rotation motor 314 is able to freely rotate the substrate holder 306.

[0032]

The transfer apparatus 200 has completely the same construction as the transfer apparatus used in the above-described deposition system 100. The deposition apparatus 402 includes a holder 404 which supports the substrate-mask unit 420 inside a vacuum chamber 416; a pressing plate 412 which can be moved in the vertical direction and which presses the substrate A against the integrated mask 1 at a

predetermined force; an evaporation source 406 of an organic material; and a moveable shutter 408 which impedes the material evaporated at the evaporation source 406 from reaching the substrate A. The pressing plate 412 is connected to a cylinder 414 fixed on an external wall 418 of the vacuum chamber 416, and is moved by the cylinder 414 in the vertical direction. The vacuum chamber 416 is fixed to a vacuum pump (not shown), and the degree of vacuum in the vacuum chamber 416 can be set to a desired value. The substrate-mask unit 420 is transferred into the vacuum chamber 416 through an opening which is normally covered by a moveable shutter 410.

[0033]

The operation of processing the substrate A in the deposition system 400 will be described below.

[0034]

First, the integrated mask 1 is placed on the mask holder 302 in the positioning apparatus 300, and the alignment marks of the integrated mask 1 are observed by the camera 310. Then, the substrate A is placed on the substrate holder 306, and the substrate holder 306 is moved downward so that the substrate A is placed on the integrated mask 1. Then, the alignment marks of the substrate A are observed by the camera 310, and the substrate holder 306 is moved upward. Then, the X-Y table 304 and the rotation motor 314 are controlled such that the positions of alignment marks of the

substrate A and the positions of the alignment marks of the integrated mask 1 are made the same. Then, the alignment marks of the integrated mask 1 and those of the substrate A are observed again, and the processes of positioning and observing the alignment marks are repeated until the alignment marks of the substrate A and those of the integrated mask 1 are observed at the same positions. Then, when the alignment marks of the substrate A and those of the integrated mask 1 are observed at the same positions, the substrate-mask unit 420, in which the substrate A is disposed on the integrated mask 1, is carried from the substrate holder 306 to the pads 208 of the transfer apparatus 200. Then, the shutter 410 of the deposition apparatus 402 is opened and the substrate-mask unit 420 is placed on the holder 404. Then, the pressing plate 412 is moved downward so that the substrate A is pressed against the integrated mask 1 at a predetermined force. The pressing force is preferably in the range of 10 to 300 N. After the slide plate 210 of the transfer apparatus 200 has moved out from the vacuum chamber 416, the shutter 410 is closed, and the vacuum pump (not shown) is driven such that the degree of vacuum in the vacuum chamber 416 is adjusted to a predetermined value. Then, the evaporation source 406 is heated so that an organic material evaporates, and the shutter 408 is opened so that the organic material adheres to the substrate A on the integrated mask 1 in accordance with

the mask pattern.

[0035]

When the deposition is completed, the shutter 408 is closed and the pressure in the vacuum chamber 416 is increased to atmospheric pressure. Then, the shutter 410 is opened and the substrate-mask unit 420, on which the organic layer is formed, is carried out by the transfer apparatus 200 and is transferred to the place where the next process is performed.

[0036]

The positioning apparatus 300 and the transfer apparatus 200 may also be disposed inside the vacuum chamber. In such a case, the substrate A and the integrated mask 1 are positioned relative to each other and transferred under vacuum conditions. Thus, the process of repeatedly changing the pressure inside the vacuum chamber between atmospheric pressure and vacuum can be omitted, and the productivity can be significantly increased.

[0037]

[Example]

Example 1

A plate formed of Ni alloy, having 84 mm wide, 105 mm long, and 25 μm thick was prepared as a deposition mask plate for forming an emitting layer. In addition, 272 rectangular apertures having 100 μm wide and 64 mm long were arranged with 300 μm pitch as the deposition apertures such that the

longitudinal direction thereof (the direction in which the dimension was 64 mm) was along the width direction of the plate (the direction in which the dimension was 84 mm). The rectangular apertures were positioned at the center of the plate in both the longitudinal and width directions of the plate. In addition, two cross-shaped alignment marks were formed on the plate on a line 5 mm away from the top end of the plate in the longitudinal direction of the plate at positions symmetrical in the width direction of the plate with a distance of 30 mm therebetween. Sixteen deposition mask plates in total were manufactured in a similar manner.

[0038]

Each of the deposition mask plates manufactured as described above was adhered to an attachment portion having 84 mm wide and 105 mm long of the frame 24 shown in Fig. 1, having 104 mm wide and 105 mm long which is formed of stainless steel, the attachment portion being positioned at the center of the frame 24 in the longitudinal direction thereof. Accordingly, sixteen deposition masks in total were manufactured. In the frame 24 of each deposition mask, the thickness of the attachment portion to which the mask plate was adhered was 10 mm, and an opening having 76 mm wide and 97 mm long was formed at the central region thereof, leaving an allowance of 4 mm at the periphery thereof. In addition, the frame 24 was 5 mm thick at parts within 10 mm from both sides in the width direction, and two fixing holes having the

diameter of 5 mm were formed at each side. Thus, four fixing holes were formed in total.

[0039]

An aluminum plate having 441 mm wide, 455 mm long, and 5 mm thick in which openings having 76 mm wide and 95 mm long were formed was prepared as the base plate 2 shown in Fig. 1. The openings were arranged in four lines in the width direction, starting at a position 19 mm from the left end with 109 mm pitch, and in four lines in the longitudinal direction, starting at a position 20 mm from the top end with 110 mm pitch. Accordingly, sixteen openings in total were formed in the base plate. Then, the above-described sixteen deposition masks were disposed on the base plate 2 in such a manner that the opening in each deposition mask was positioned at the center of the corresponding opening in the base plate 2. Then, the deposition masks were retained to the base plate using four engaging units for each deposition mask, and thus the integrated mask 1 was manufactured. The thickness of a part of the base plate within 10 mm from the top end in the longitudinal direction thereof was 15 mm. In this part of the integrated mask, two holes having 1 mm in diameter and 5 mm deep were formed as the alignment marks such that the holes were centered on a line 5 mm away from the top end and were positioned in the central region in the width direction with a distance of 30 mm therebetween. The surface on which the alignment marks were formed and the top

surface of the deposition masks 1 attached to the base plate were at the same height. The engaging units were formed of stainless steel. The diameter of the head of the restraining pin 42 was 8 mm, and the diameter of the shaft portion of the restraining pin 42 which was inserted through the hole formed in the base plate was 4 mm. In addition, spring constant of the compression spring 44 was 10 N/mm, and each of the deposition masks was pressed against the base plate at 100 N. In addition, the deposition masks were positioned such that the alignment marks of the deposition masks were at predetermined positions using the alignment marks on the base plate as the reference.

[0040]

This integrated mask 1 was used for forming a green emitting layer and was attached to the mask holder 112 in the deposition apparatus 102 for forming the green emitting layer. Then, an integrated mask for forming a red emitting layer was manufactured similarly to the integrated mask for forming the green emitting layer except that the positions of the apertures having 100 μm wide and 64 mm long formed in the mask plate were shifted by 100 μm (length corresponding to one pitch) in the longitudinal direction of the plate. In addition, an integrated mask for forming a blue emitting layer was manufactured similarly to the integrated mask for forming the green emitting layer except that the positions of the apertures having 100 μm wide and 64 mm long formed in the

mask plate were shifted by 200 μm (length corresponding to two pitches) in the longitudinal direction of the plate. Thus, preparation for depositing all of the green, red, and blue emitting layers was completed.

[0041]

Next, a 130 nm thick ITO transparent electrode layer was formed over the entire surface of a non-alkali glass substrate having 1.1 mm thick, 457 mm wide, and 455 mm long by sputtering. Then, first electrodes were formed by photolithography using a shadow mask having a pattern such that sixteen striped patterns were arranged with 109 mm pitch in the width direction of the substrate and with 110 mm pitch in the longitudinal direction of the substrate, each striped pattern including 816 lines, having 90 mm long and 80 μm wide extending in the width direction of the substrate and being arranged in the longitudinal direction of the substrate with 100 μm pitch. The distance between the edge of the glass substrate and the nearest striped pattern was 20 mm in the width direction of the substrate and 22 mm in the longitudinal direction of the substrate.

[0042]

Then, a 3 μm thick layer of positive photoresist (OFPR-800, manufactured by Tokyo Ohka Kogyo Co., Ltd.), was formed over the entire surface of the substrate by a spinner. Then, the substrate was dried, and exposure using a photomask and development of the photoresist was performed, so that a

predetermined pattern was formed. Then, a curing process was performed at 180°C. Accordingly, sixteen spacer units were formed on sixteen effective luminescent areas (areas including the first electrodes and R, G, and B emitting layers) of the sixteen organic EL devices. In each spacer unit, holes (spaces where no spacer was provided) having the size of 65 μm in the longitudinal direction of the substrate (direction perpendicular to the first electrodes) and 235 μm in the width direction of the substrate were arranged in 816 lines in the longitudinal direction of the substrate with 100 μm pitch so that the first electrodes were exposed, each line including 200 holes aligned in the width direction of the substrate, that is, in the longitudinal direction of the first electrodes, with 300 μm pitch. In addition, in each spacer unit, the left edge of the holes was 15 mm away from the left edge of the first electrodes in the width direction of the substrate.

[0043]

Next, a 15 nm thick copper phthalocyanine layer and a 60 nm thick bis(N-ethylcarbazole) layer were formed over the effective luminescent areas of the sixteen organic EL devices by deposition. Thus, a hole-transfer layer was formed. The degree of vacuum during the deposition process was 2×10^{-4} Pa or less, and the substrate was rotated relative to the evaporation source during the deposition.

[0044]

Then, in order to form the emitting layer by deposition, the integrated mask 1 was disposed in the deposition apparatus and the alignment marks were observed by the camera. Then, the glass substrate, on which the hole-transfer layer was formed, was placed on the substrate holder 122 by the transfer apparatus 200, and the vacuum pump was driven such that the degree of vacuum in the vacuum chamber was set to 1 $\times 10^{-4}$ Pa. Then, after the predetermined degree of vacuum has been obtained, the substrate holder 122 was moved downward and the glass substrate on the substrate holder 122 was placed on the integrated mask 1. This glass substrate was provided with two through holes having 1 mm in diameter as the alignment marks such that the through holes were centered on a line 5 mm away from the top end in the longitudinal direction of the substrate and were positioned in the central region of the substrate in the width direction with a distance of 30 mm therebetween. Accordingly, the relative position between the glass substrate and the integrated mask 1 was adjusted such that the alignment marks of the glass substrate and the alignment marks of the base plate of the integrated mask 1 were at the same positions. After the positioning process, the glass substrate was pressed against the integrated mask 1 by the pressing member at 20 N. Then, the evaporation source was heated, and 8-hydroxyquinoline-aluminum complex (Alq3) doped with 0.3 wt%

1,3,5,7,8-pentamethyl-4,4-difloro-4-bora-3a,4a-diaza-s-indacene (PM546) was deposited in a pattern corresponding to the mask pattern of the integrated mask, so that a 20 nm thick green emitting layer was formed.

[0045]

Then, the substrate on which the green emitting layer was formed was taken out and was transferred to another deposition apparatus in which the integrated mask for forming a red emitting layer was disposed. Then, the relative position between the substrate and the integrated mask was adjusted similarly to the above-described case in which the green emitting layer was formed. Then, Alq3 doped with 1 wt% 4-(dicyanomethylene)-2-methyl-6(julolidinyl-9-ethenyl)pyran (DCJT) was deposited on the substrate under the vacuum condition of 1×10^{-4} Pa, so that a 15 nm thick red emitting layer was formed. Then, the substrate was transferred to another deposition apparatus in which the integrated mask for forming a blue emitting layer was disposed. Then, the relative position between the substrate and the integrated mask was similarly adjusted, and 4,4'-bis(2,2'diphenylvinyl)diphenyl (DPVBi) was deposited on the substrate under the vacuum condition of 1×10^{-4} Pa, so that a 20 nm thick blue emitting layer was formed.

[0046]

The emitting layers were formed on the first electrodes arranged in a striped pattern, so that the exposed parts of

the first electrodes were completely covered.

[0047]

Next, DPVBi was deposited at 45 nm and Alq3 was deposited at 10 nm over the effective luminescent areas of the sixteen organic EL devices. Then, second electrodes were formed by depositing aluminum on the substrate such that sixteen striped patterns were arranged with 109 mm pitch in the width direction of the substrate and with 110 mm pitch in the longitudinal direction of the substrate, each striped pattern including 200 aluminum lines, having 100 mm long, 250 μm wide, and 240 nm thick extending in the longitudinal direction of the substrate (direction perpendicular to the first electrodes) and being arranged in the width direction of the substrate with 300 μm pitch. The degree of vacuum during the deposition process was 3×10^{-4} Pa or less. Then, silicone monoxide was deposited at 200 nm as a protection layer by electron beam deposition.

[0048]

The thus obtained substrate including sixteen emitting devices was cut so that the sixteen emitting elements were separated. In each luminescent element, thin film layers including a first electrode layer formed of 816 ITO electrodes arranged in a striped pattern, R, G, and B emitting layers formed on the first electrode layer, and a second electrode layer formed of 200 second electrodes arranged perpendicularly to the first electrodes in a striped

pattern, were formed. In the intersections of the first electrodes and the second electrodes, only the regions where the holes surrounded by the spacer were formed emitted light. In addition, one pixel was formed of three luminescent units corresponding to R, G and B colors. Accordingly, passive-matrix color organic EL devices having 272 × 200 pixels with 300 μm pitch were manufactured. All of the thus manufactured sixteen organic EL devices had the luminescence characteristics suitable to be used as a display. In addition, since the emitting layers were deposited using the deposition masks which were separated from each other, all of the sixteen luminescent elements had the same dimensional accuracy and the same characteristics. In addition, the displacements between the R, G, and B emitting layers were within 5 μm in all of the sixteen organic EL devices. For the purpose of comparison, sixteen organic EL devices were manufactured using a single deposition mask in which deposition patterns corresponding to sixteen organic EL devices were formed in a single plate. In this case, displacements between the R, G, and B emitting layers differed among the sixteen organic EL devices, and were in the range of 5 to 200 μm. Therefore, only two organic EL devices could be used as a display.

[0049]

In the above-described examples, three integrated masks were used for forming R, G, and B emitting layers. However,

a single integrated mask may also be used for forming all of the R, G, and B emitting layers by shifting the relative position between the integrated mask and the substrate by the amount corresponding to one pitch of the first electrodes.

[0050]

In addition, although the mask deposition method was also used in the process of forming the second electrodes, the metal electrodes may also be formed without using the deposition mask. In such a case, walls may be formed on the substrate in advance, and the second electrodes may be formed by using the shadows of the walls. Furthermore, the second substrates may also be encapsulated by a known technique after the deposition process.

[0051]

Although passive-matrix color organic EL devices were manufactured in the above-described example, monochrome organic EL devices may also be manufactured by omitting the processes of forming the emitting layers in a precise pattern. In addition, active matrix color organic EL devices may also be manufactured using a substrate including switching elements such as thin film transistors (TFTs) and forming a pattern in the emitting layers using the integrated mask.

[0052]

[Advantages]

In the integrated mask of the present invention, a plurality of deposition masks, each of which has an array of

deposition apertures, are arranged on a base plate using the alignment marks of the integrated mask and those of the deposition masks, and are retained to the base plate in a disengageable manner. Accordingly, multiple deposition masks can be disposed at predetermined positions with high accuracy.

[0053]

In addition, in the method and apparatus for manufacturing the organic EL device of the present invention, the step of positioning the integrated mask and the substrate and the step of forming a thin film layer, for example, an emitting layer and a second electrode layer, are performed using the above-described integrated mask. Accordingly, the thin film layer can be formed in a predetermined pattern by deposition at high dimensional accuracy, irrespective of the size of the substrate on which the thin film layer is In addition, since multiple organic EL devices can be formed on a single substrate at high pattern accuracy, high quality organic EL devices can be manufactured with high productivity.

[Brief Description of the Drawings]

[Fig. 1] A schematic perspective view showing an overall construction of an integrated mask 1 according to the present invention.

[Fig. 2] An exploded perspective view of the integrated mask shown in Fig. 1.

[Fig. 3] A front sectional view showing an embodiment of a deposition apparatus using the integrated mask.

[Fig. 4] A front sectional view showing another embodiment of a deposition apparatus using the integrated mask.

[Reference Numerals]

1: integrated mask

2: base plate

6: alignment marks

10: openings

20: deposition masks

22: mask plates

30: aperture arrays

32: deposition apertures

40: engaging units

42: restraining pins

44: compression springs

46: catches

100: deposition system

102: deposition apparatus

104: looking glass

106: deposition shutter

108: external wall

110: bracket

112: mask holder

116: X-Y guide

120: bracket

122: substrate holder

124: pressing member

126: elevation shaft

128: motor

130: camera

132: vacuum chamber

134: evaporation source

136: shutter

200: transfer apparatus

210: slide plate

208: pads

400: deposition system

402: deposition apparatus

300: positioning apparatus

302: mask holder

306: substrate holder

314: rotation motor

416: vacuum chamber

404: holder

406: evaporation source

408: shutter

412: pressing plate

420: substrate-mask unit

A: substrate

[Name of Document] ABSTRACT

[Abstract]

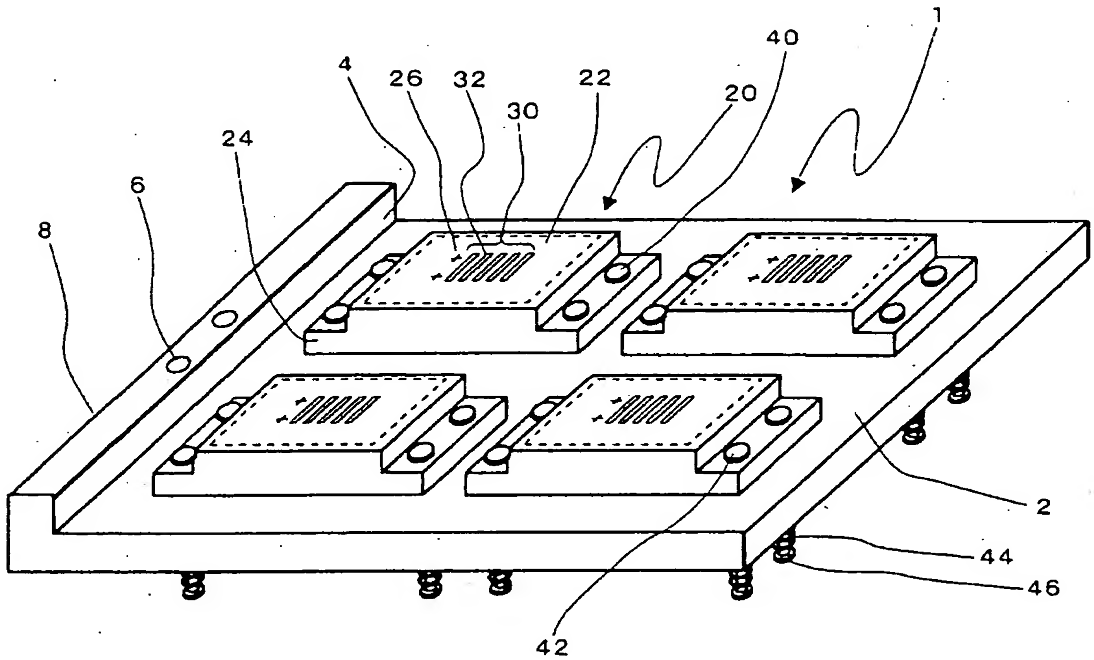
[Object] To provide a deposition mask in which multiple small deposition masks are arranged on a single substrate so that multiple organic EL devices can be formed by deposition with high accuracy, and to provide a method and apparatus for manufacturing an organic EL device using the deposition mask.

[Solving Means] An integrated mask includes a plurality of deposition masks, each deposition mask having an array of deposition apertures formed in accordance with a deposition pattern and a base plate having a plurality of openings, wherein the deposition masks are arranged on the base plate such that the arrays of deposition apertures are positioned above the respective openings and are retained to the base plate by engaging means in a disengageable manner, and wherein alignment marks used for positioning the deposition masks on the base plate are formed on the base plate.

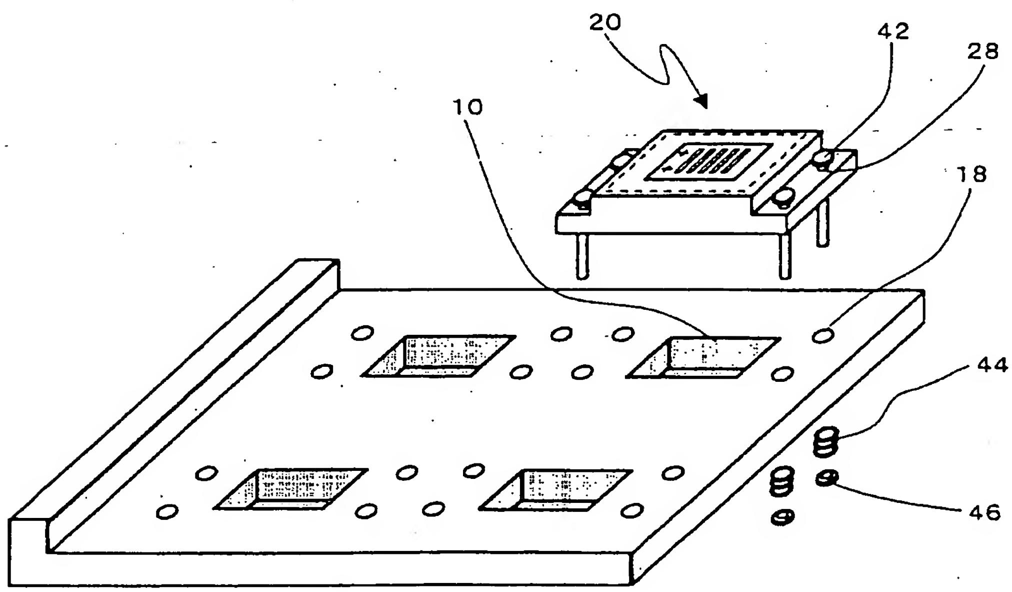
[Selected Figure] Fig. 1

【書類名】　図面　Drawings

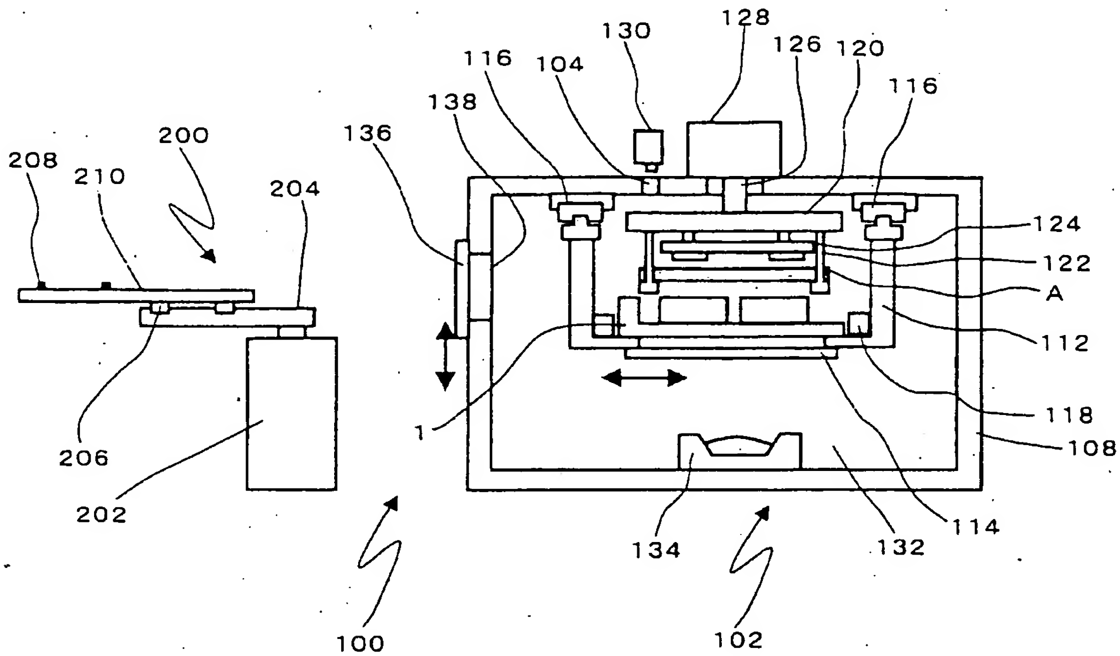
【図１】　Fig. 1



【図２】　Fig. 2



【図３】　Fig. 3



【図４】　Fig. 4